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(54) APPARATUS AND METHOD FOR TRACKING AND MANAGING PHYSICAL ASSETS

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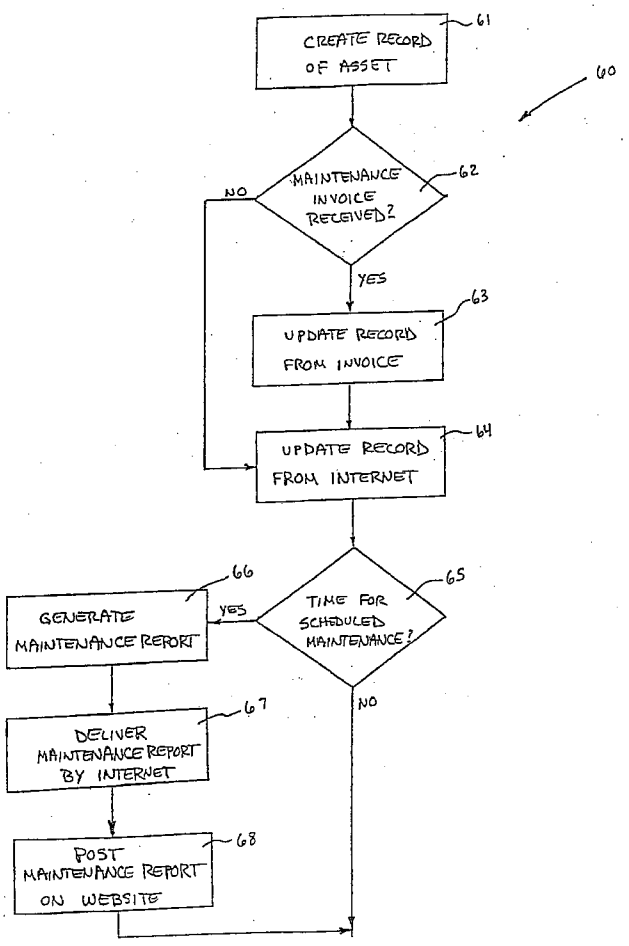
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(57) **ABSTRACT**

A computer based system automatically gathers, analyzes, and delivers information relating to the procurement and utilization of a plurality of such assets, such as a fleet of industrial equipment, so as to maximize productivity and to reduce operating costs and administrative burdens. Each of the assets is preferably provided with a data acquisition device for sensing and storing one or more operating characteristics associated therewith. That information can be transmitted through space to a receiver connected to a local controller for storing such information and for transmitting such information to a remote analysis system. The remote analysis system automatically updates individual records associated with each of the assets with the information received. In response to such information, the remote analysis system automatically analyzes the newly provided information and schedules maintenance as required. Information associated with the maintenance is also recorded electronically to maximize efficiency, provide historical trends, automate billing, and control inventory levels.



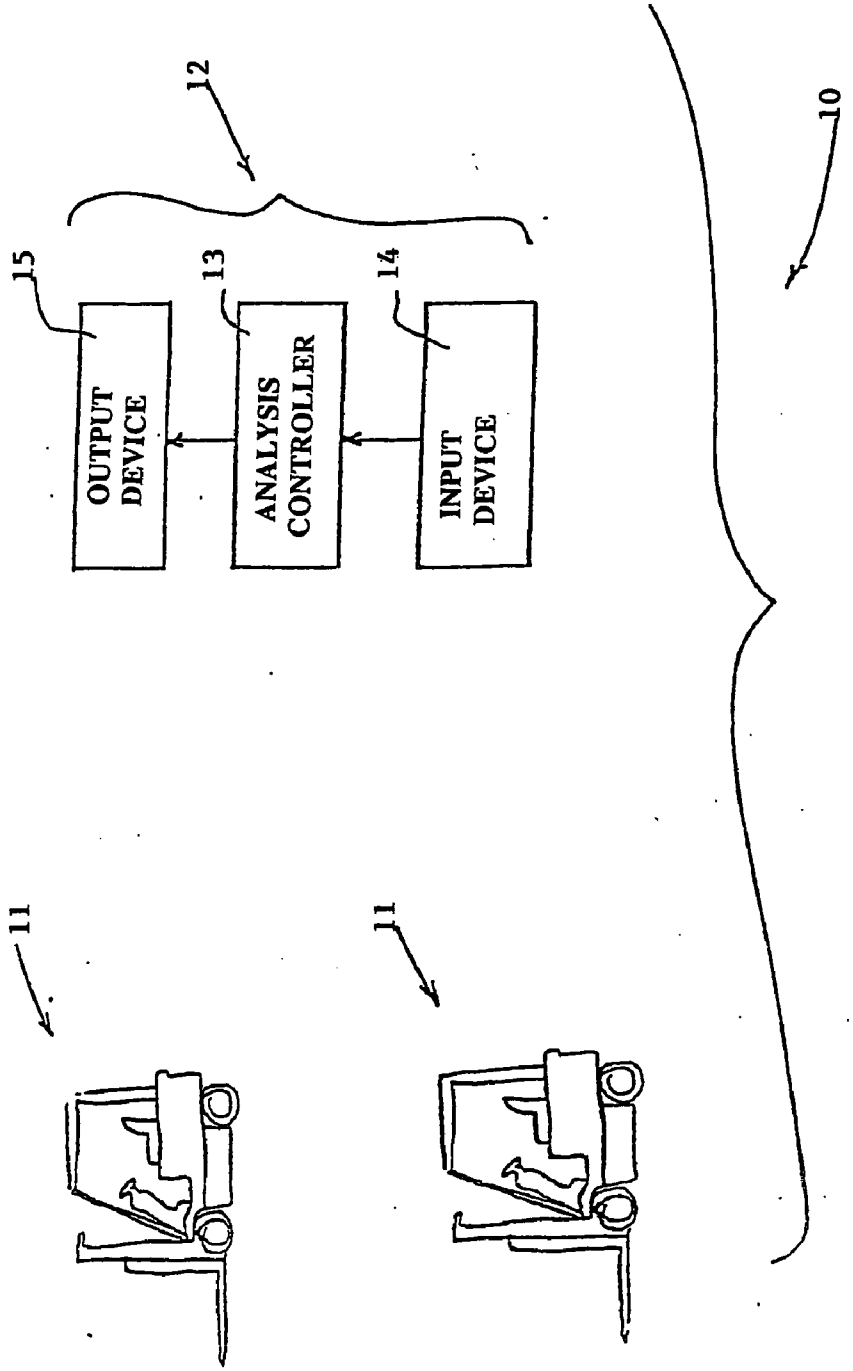


FIGURE 1
(PRIOR ART)

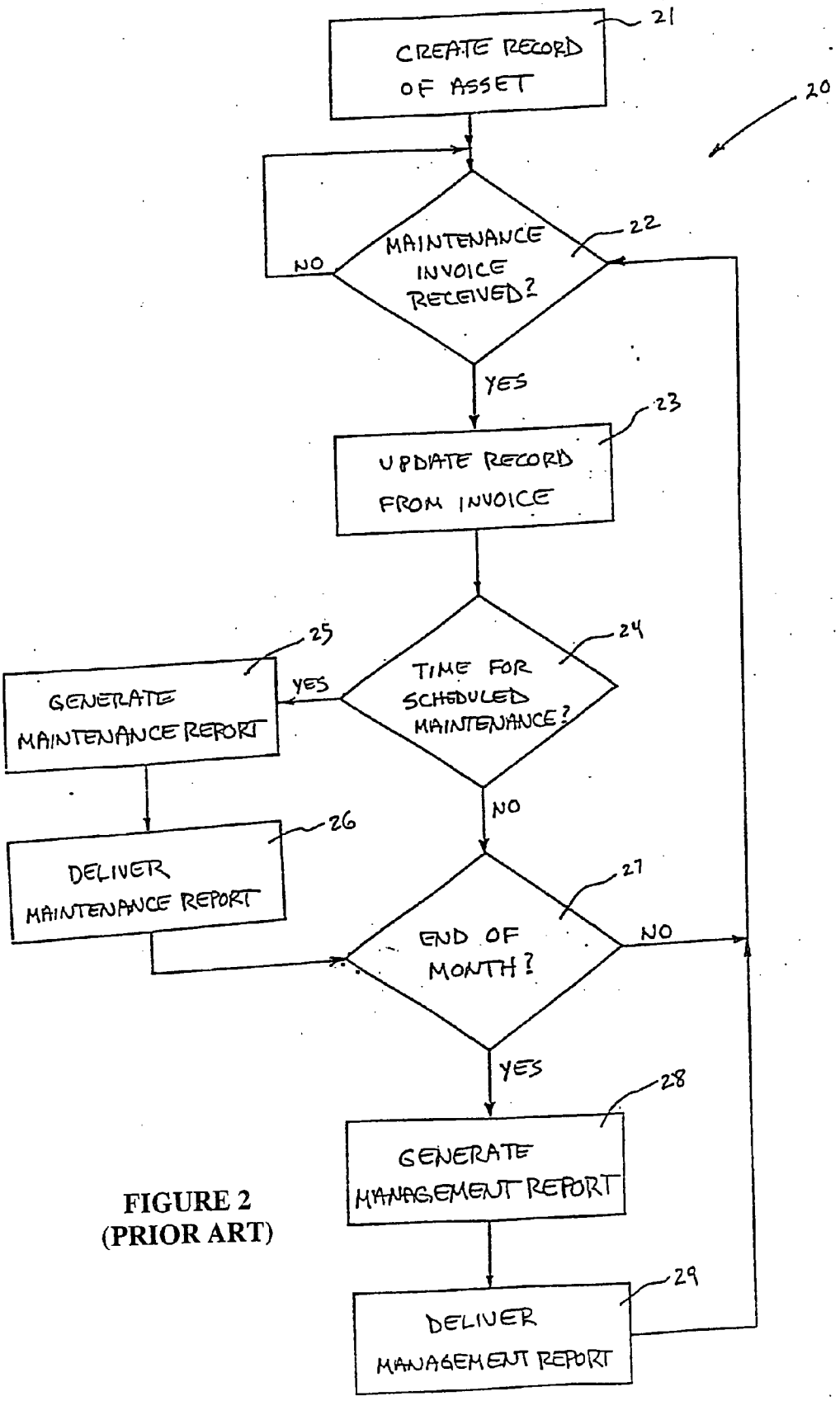


FIGURE 2
(PRIOR ART)

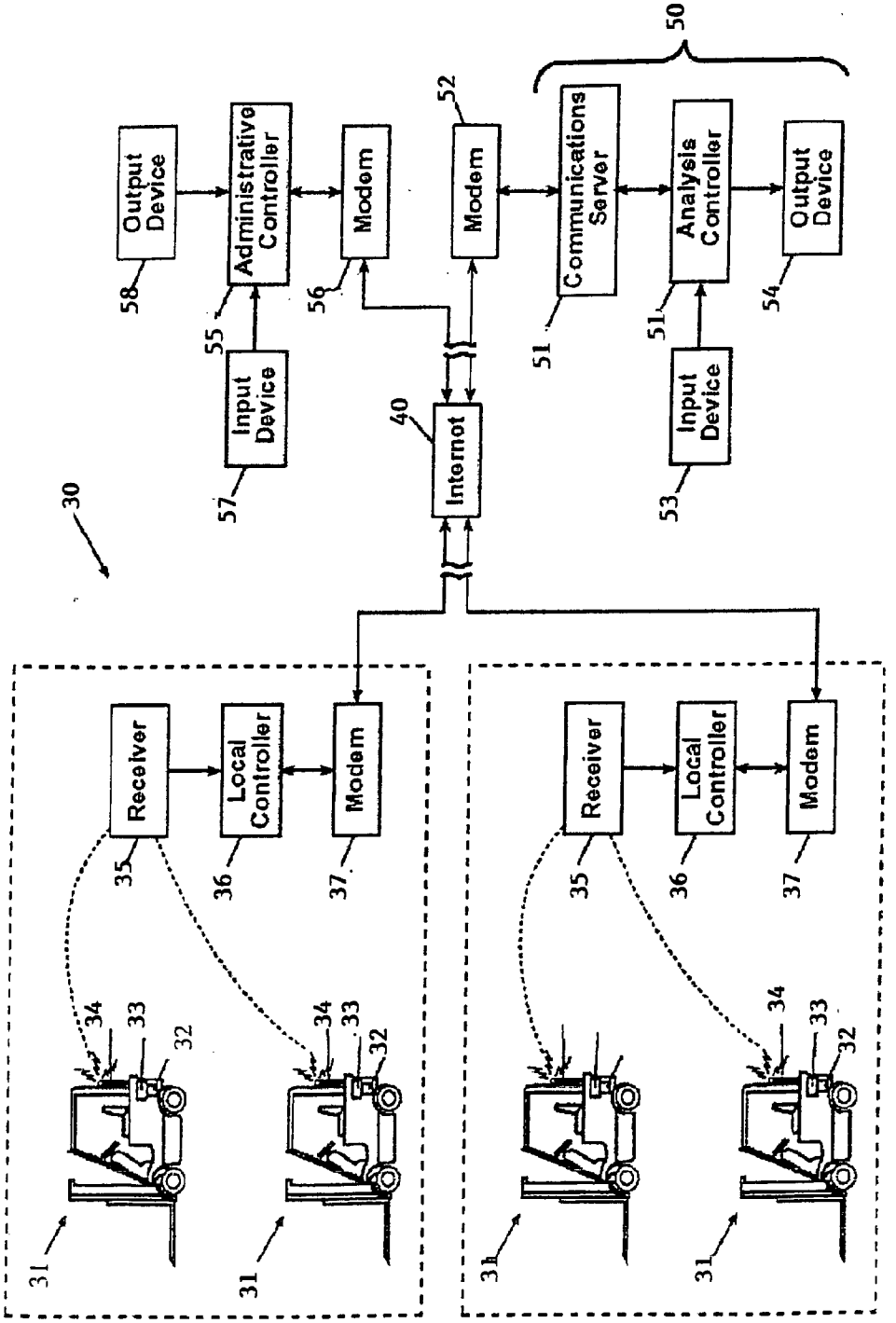

30
Output Device
58
Administrative Controller
55
Input Device
57
Modem
56
Modem
52
Internet
40
50
Communications Server
51
Analysis Controller
51
Input Device
53
Output Device
54
Receiver
35
Local Controller
36
Modem
37
34
33
32
31
Receiver
35
Local Controller
36
Modem
37
34
33
32
31

FIGURE 3

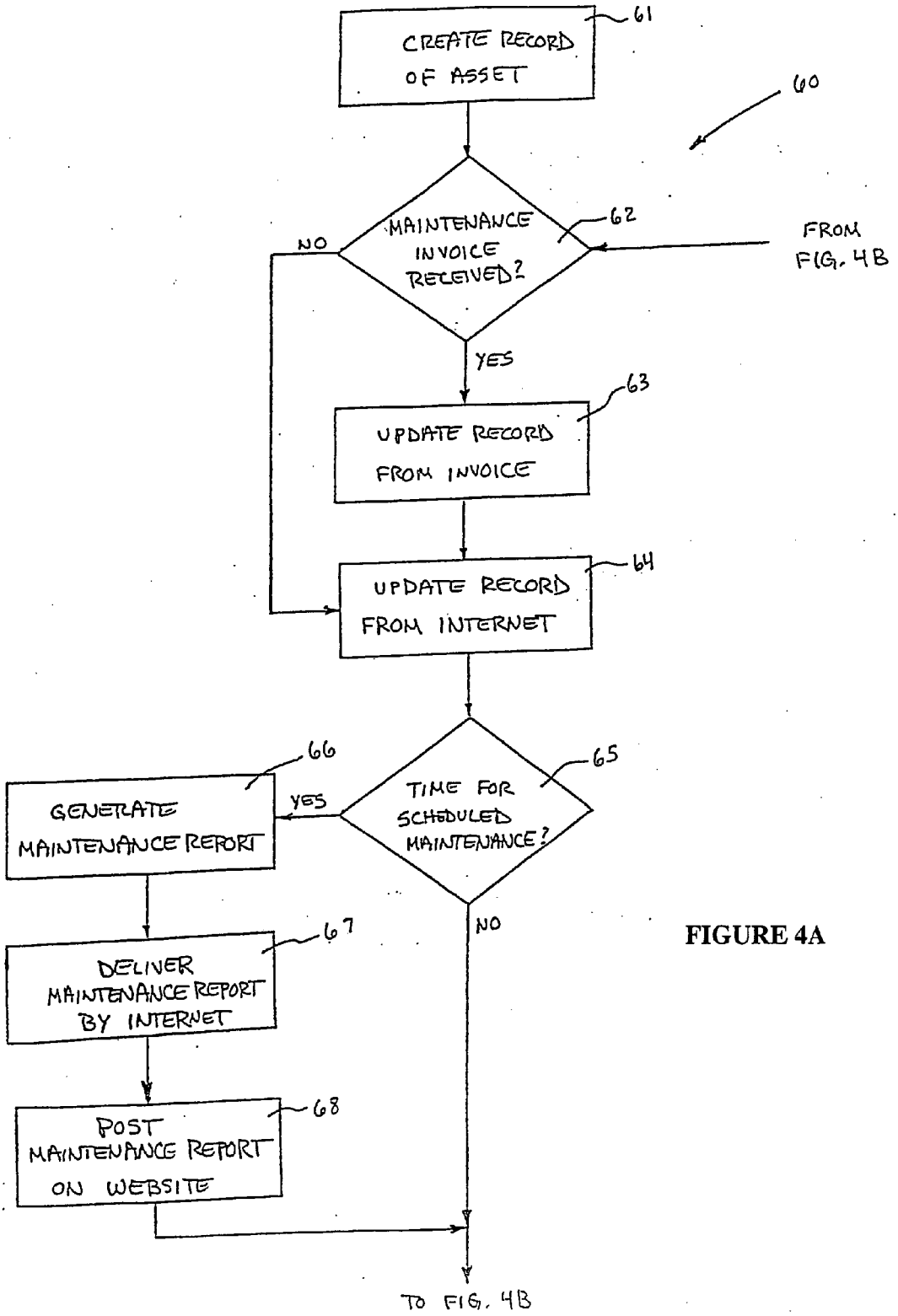

CREATE RECORD OF ASSET
61
60
MAINTENANCE INVOICE RECEIVED?
62
NO
FROM FIG. 4B
YES
UPDATE RECORD FROM INVOICE
63
UPDATE RECORD FROM INTERNET
64
TIME FOR SCHEDULED MAINTENANCE?
65
YES
GENERATE MAINTENANCE REPORT
66
NO
DELIVER MAINTENANCE REPORT BY INTERNET
67
POST MAINTENANCE REPORT ON WEBSITE
68
TO FIG. 4B

FIGURE 4A

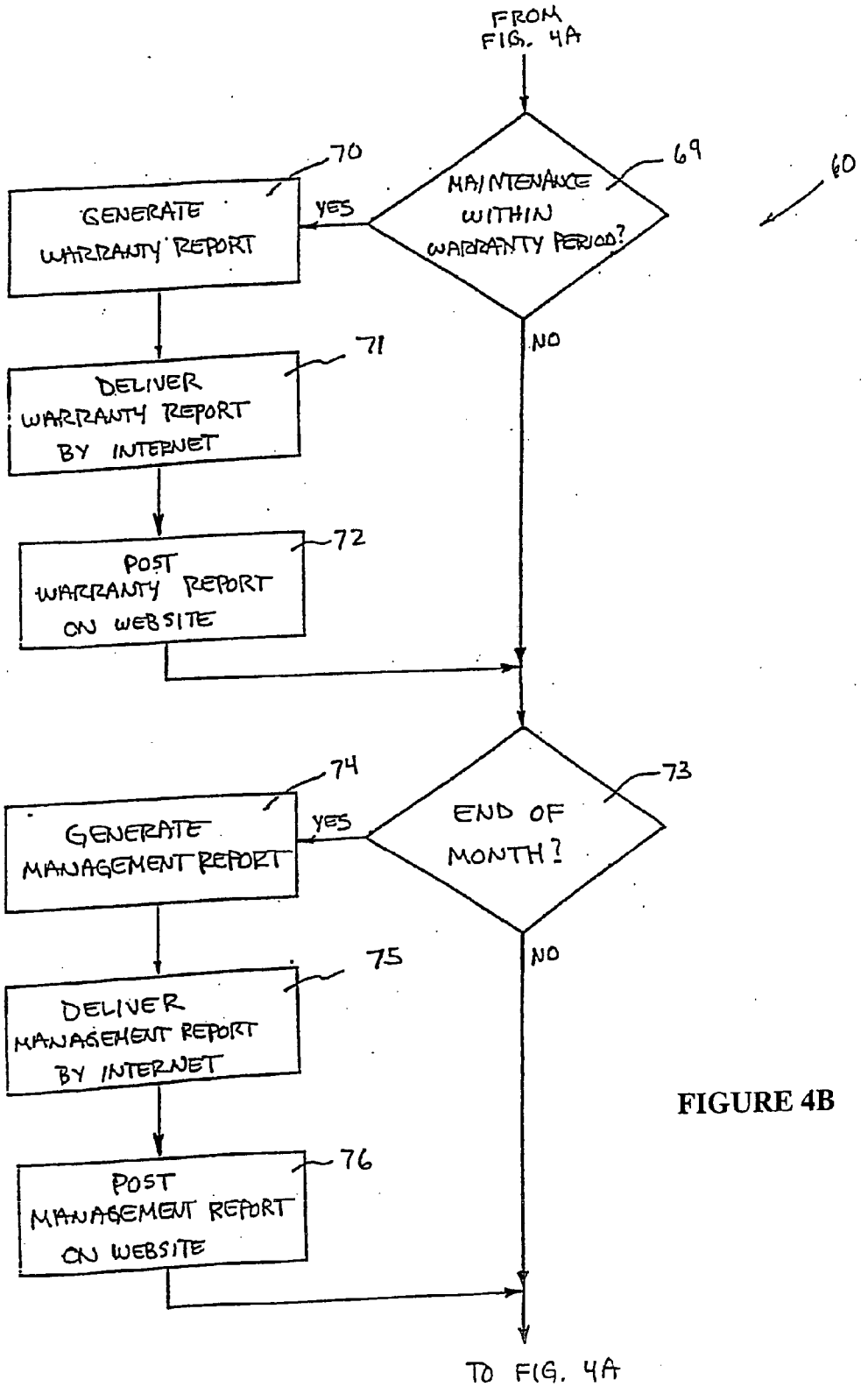

FROM FIG. 4A
MAINTENANCE WITHIN WARRANTY PERIOD?
69
60
YES
NO
GENERATE WARRANTY REPORT
70
DELIVER WARRANTY REPORT BY INTERNET
71
POST WARRANTY REPORT ON WEBSITE
72
END OF MONTH?
73
GENERATE MANAGEMENT REPORT
74
DELIVER MANAGEMENT REPORT BY INTERNET
75
POST MANAGEMENT REPORT ON WEBSITE
76
TO FIG. 4A

FIGURE 4B

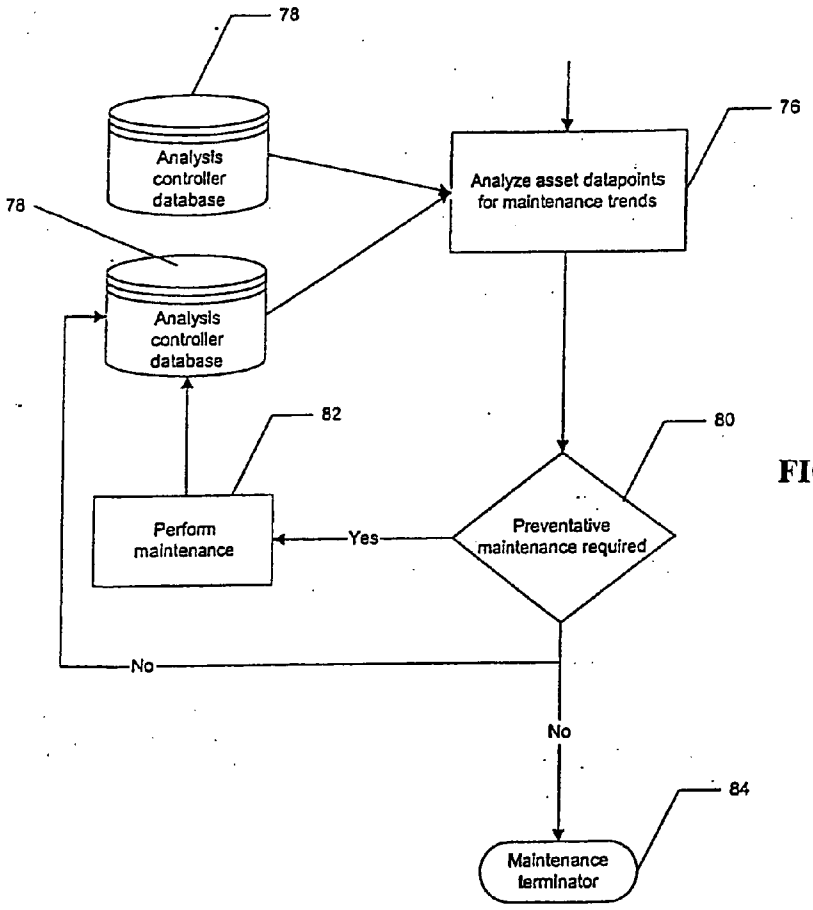


FIGURE 4C

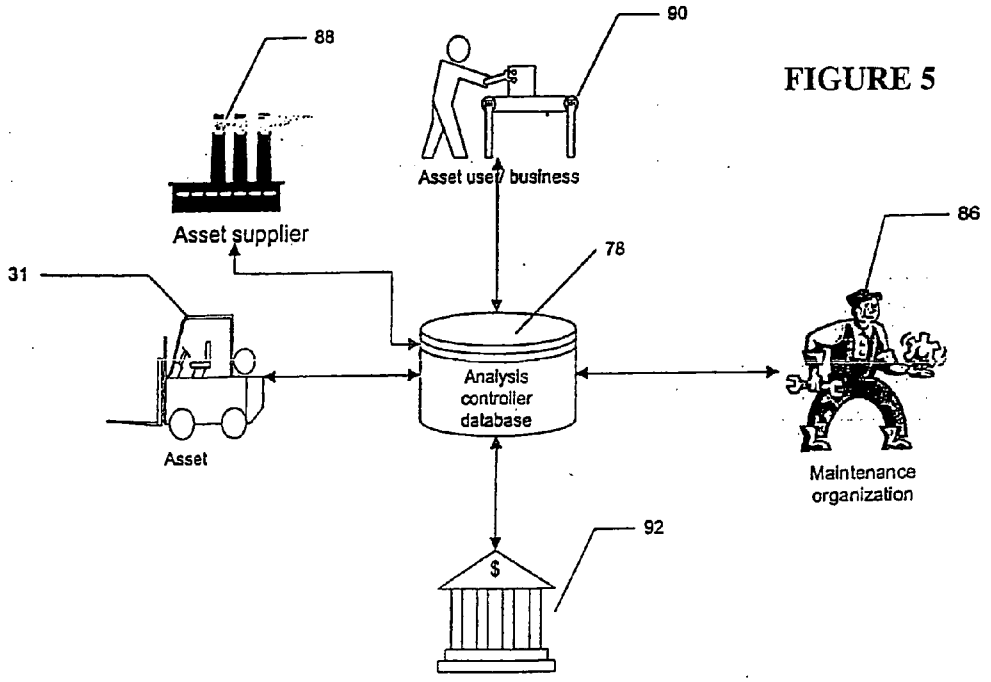


FIGURE 5

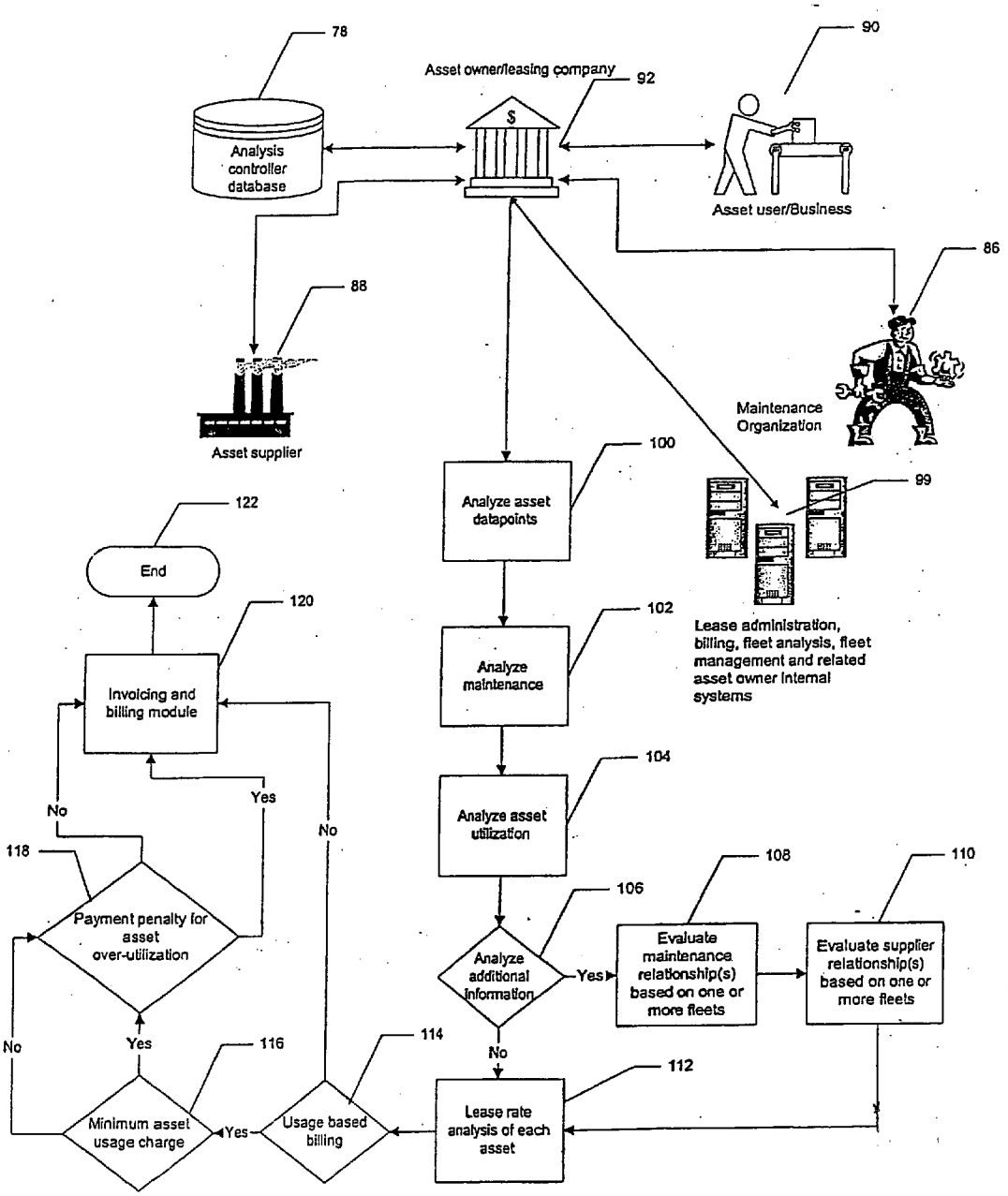
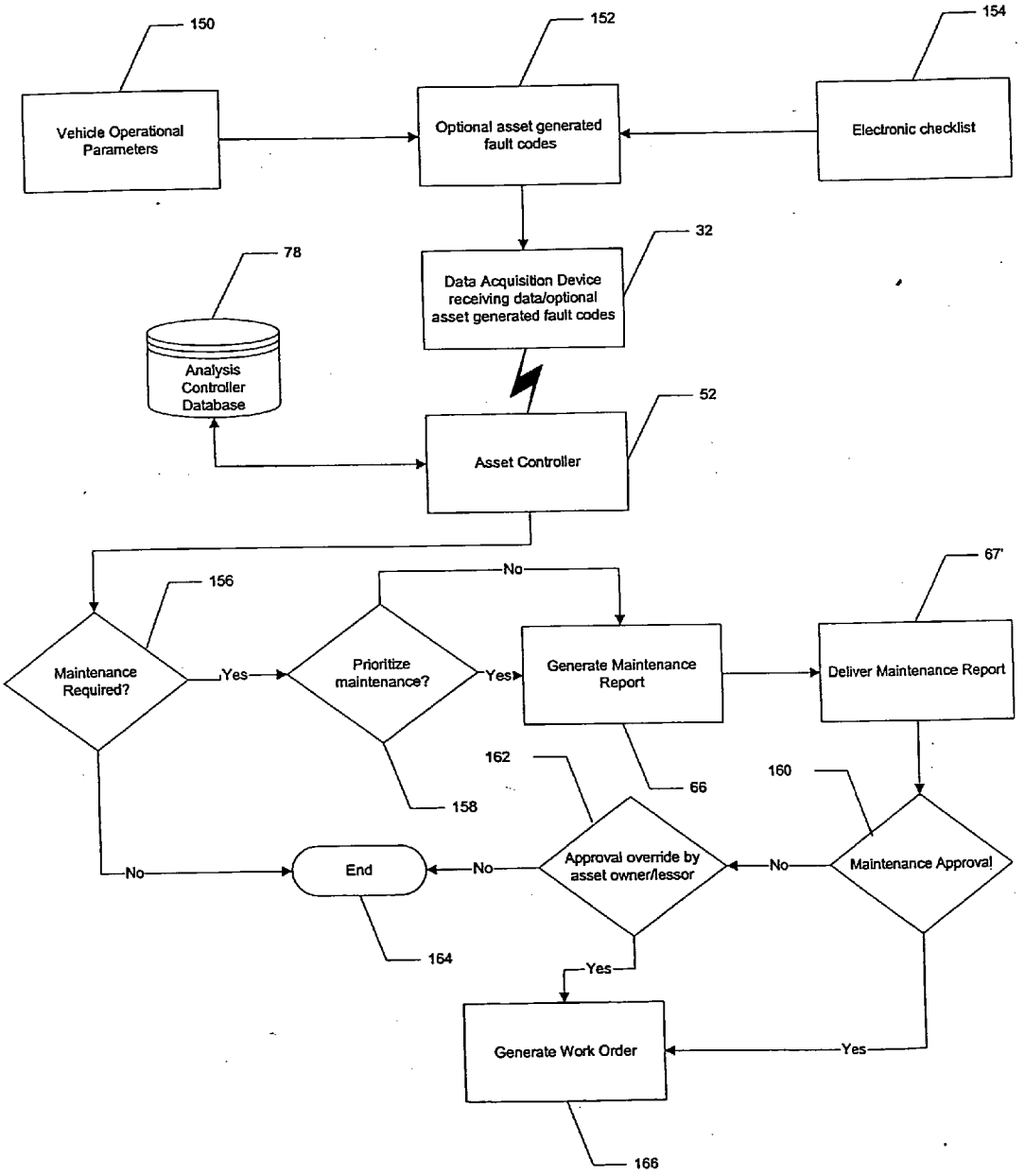

78
Analysis controller database
Asset owner/leasing company
92
$
90
Asset user/Business
86
88
Asset supplier
Maintenance Organization
100
Analyze asset datapoints
99
Lease administration, billing, fleet analysis, fleet management and related asset owner internal systems
122
End
120
Invoicing and billing module
102
Analyze maintenance
104
Analyze asset utilization
106
Analyze additional information
Yes
108
Evaluate maintenance relationship(s) based on one or more fleets
110
Evaluate supplier relationship(s) based on one or more fleets
No
112
Lease rate analysis of each asset
114
Usage based billing
Yes
116
Minimum asset usage charge
Yes
No
118
Payment penalty for asset over-utilization
Yes
No
No
Yes

FIGURE 6

Fig. 7


150
152
154
Vehicle Operational Parameters
Optional asset generated fault codes
Electronic checklist
78
32
Analysis Controller Database
Data Acquisition Device receiving data/optional asset generated fault codes
52
Asset Controller
156
No
67'
Maintenance Required?
Yes
Prioritize maintenance?
Yes
Generate Maintenance Report
Deliver Maintenance Report
162
160
158
66
No
End
No
Approval override by asset owner/lessor
No
Maintenance Approval
164
Yes
Generate Work Order
Yes
166

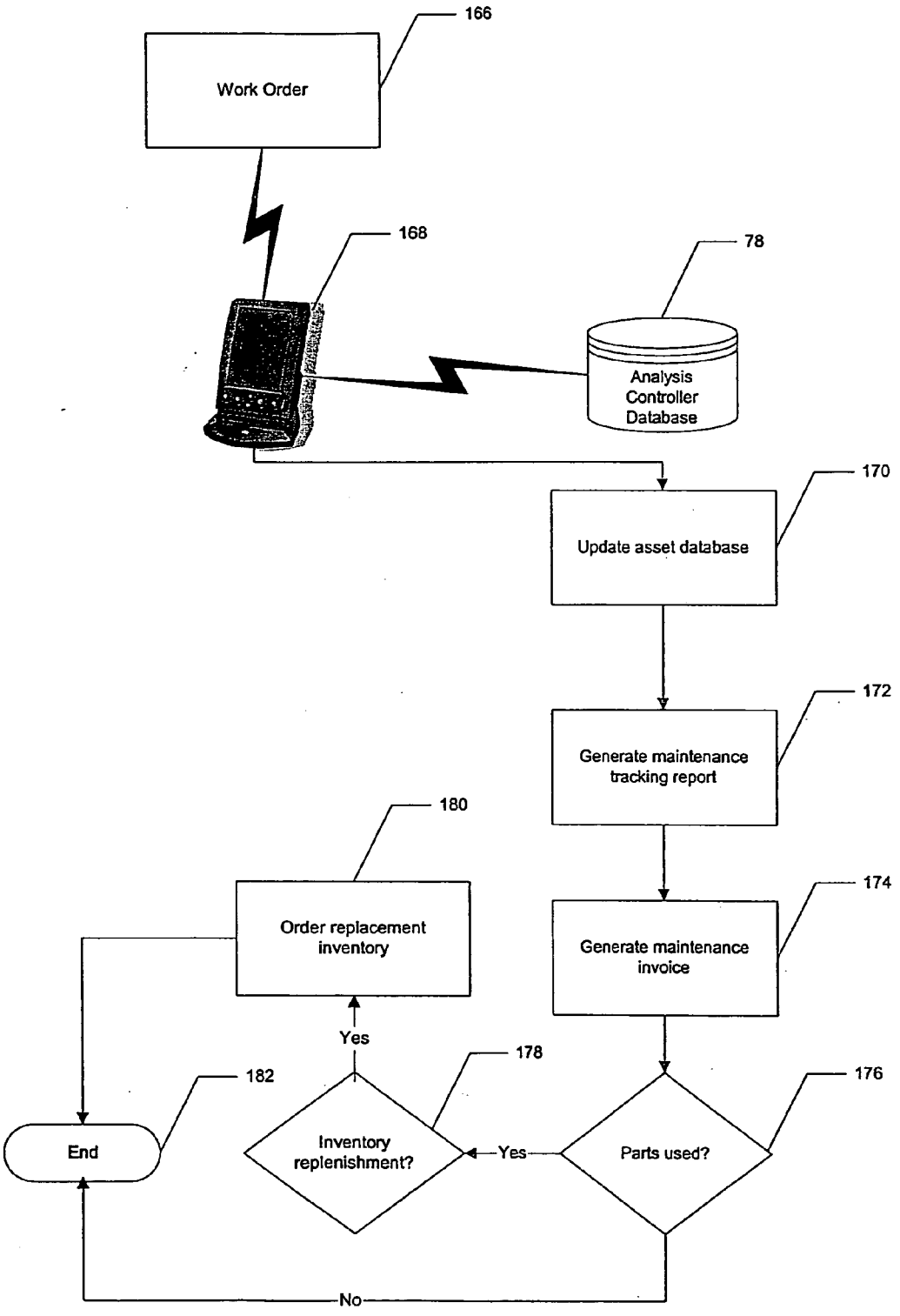

166
Work Order
168
78
Analysis Controller Database
170
Update asset database
172
Generate maintenance tracking report
180
Order replacement inventory
174
Generate maintenance invoice
Yes
178
182
176
End
Inventory replenishment?
Yes
Parts used?
No

Fig. 8

APPARATUS AND METHOD FOR TRACKING AND MANAGING PHYSICAL ASSETS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. application Ser. No. 09/702,363, filed Oct. 31, 2000, currently co-pending and claiming the benefit of U.S. application Ser. No. 09/441,289 filed Nov. 16, 1999, U.S. Provisional Application Ser. No. 60/166,042 filed Nov. 17, 1999, U.S. application Ser. No. 09/503,671 filed Feb. 14, 2000, U.S. application Ser. No. 09/504,000 filed Feb. 14, 2000, U.S. application Ser. No. 09/504,343 filed Feb. 14, 2000, and U.S. application Ser. No. 09/653,735 filed Sep. 1, 2000, the contents of which are all hereby incorporated in their entirety by reference.

BACKGROUND

[0002] The present invention relates in general to systems for tracking and managing physical assets to promote the efficient maintenance of the assets while reducing cost. In particular, this invention relates to a computer based system for automatically gathering, analyzing, and delivering information relating to the maintenance of a plurality of such assets, such as a fleet of industrial equipment, so as to maximize productivity and to reduce the operating costs and administrative burdens associated with such assets.

[0003] Many businesses operate a plurality of physical assets to assist in the performance of the daily activities that are required to produce goods or services. For example, a typical manufacturer of goods often uses a fleet of industrial equipment, such as forklifts, conveyors, machine tools, and the like, in its daily operations to facilitate the manufacture of goods for its customers. In a similar manner, a typical provider of services also often employs a plurality of assets, such as computers, communications equipment, photo imaging equipment, and the like, in its daily operations to facilitate the performance of services for its customers. Traditionally, businesses have purchased such assets for use in their facilities and have employed staff to operate and maintain the assets in furtherance of the manufacture of goods or the performance of services.

[0004] Regardless of the specific nature of the business, the operation of these assets has usually been considered to be somewhat ancillary to the core nature of the business. In other words, although the use of these assets is helpful (indeed, sometimes necessary) for the business to manufacture the goods or provide the services in a cost efficient manner, the ownership, operation, and maintenance of such assets is not, of itself, a core function of the business. Consequently, the costs associated with the procurement and utilization of such assets have not been traditionally monitored or analyzed by the business in great detail. Rather, such costs have usually been considered to be relatively fixed costs of doing business, and any management of such assets has been performed, if at all, by relatively low level employees having little training or inclination to increase productivity and reduce costs.

[0005] Obviously, many businesses have been able to produce goods and provide services without actively managing the costs of obtaining and operating these assets. However, optimization of productivity and minimization of costs are key considerations in the modem business environment. Thus, it would be desirable to provide a computer based system for automatically gathering, analyzing, and delivering information relating to the procurement and utilization of a plurality of such assets, such as a fleet of industrial equipment, so as to maximize productivity and to reduce operating costs and administrative burdens associated with such assets.

[0006] It would also be desirable to be able to provide different parties having an interest in the asset ready access to up-to-date real-time and historical access to the information associated with asset usage, maintenance, performance, and the like. For example, besides the business using the asset, there is often a third party maintenance organization that helps to maintain the asset and a leasing company acting as the true asset owner that leases the asset to the business. Because the leasing company lacks appropriate information concerning the asset, the leasing arrangement typically takes this lack of information into account as part of the lease transaction, often through a combination of both a fixed lease amount tied to the asset regardless of use, as well as a financial cushion for the benefit of the true asset owner to cover unforeseen problems associated with the asset including over-use and improper maintenance.

[0007] It is known to record and store operational parameters or fault codes associated with the asset, which may be transmitted using a communications network to a central location for the purpose of undertaking diagnostics. It is also known to use handheld devices for the real-time sharing of information with a central system. The handheld device can access information from the central system such as the status of available inventory. The central system can also provide instructions to a user of the handheld device. Finally, it is known to use various electronic systems for monitoring inventory.

[0008] However, if each of the entities involved with an asset had ready access to the same information concerning the asset, and the ability to update that information as well as related information associated with maintenance of the asset on a real-time basis, the involved parties may be willing to share an increased portion of the financial risk/reward associated with the usage, maintenance, performance, or the like with respect to the asset. With appropriate objective information it may be possible to distribute a portion of the responsibility to other responsible third parties including the asset manufacturer or supplier, and asset maintenance organization.

SUMMARY OF THE INVENTION

[0009] This invention relates to a computer based system for automatically gathering, analyzing, and delivering information relating to the procurement and utilization of a plurality of such assets, such as a fleet of industrial equipment, so as to maximize productivity and to reduce operating costs and administrative burdens. Each of the assets is preferably provided with a data acquisition device for sensing and storing one or more operating characteristics associated therewith such as a fault code generated by the asset when there is a maintenance problem or when routine maintenance is required in accordance with predetermined criteria. That information can be transmitted through space to a receiver connected to a local controller for storing such

information and for transmitting such information over the Internet to a remote analysis system. The remote analysis system automatically updates individual records associated with each of the assets with the information received from the Internet. In response to such information, the remote analysis system automatically analyzes the newly provided information and generates reports regarding scheduled maintenance, warranty coverage, and other management information. These reports can be transmitted back over the Internet to an administrative controller for review by one or more persons responsible for managerial review. Additionally or alternatively, the remote analysis system can automatically post such reports on a website and, thus, be made available to one or more of such persons upon request.

[0010] Not only can the information be provided to an administrative controller, but it can be provided to third parties such as maintenance organizations, asset manufacturers or suppliers, and leasing companies. By providing up-to-date real-time and historical information concerning the asset, such third parties are willing to share the risk of the asset's usage, maintenance, and performance through creative arrangements with the asset user. A maintenance organization, for example, may be willing to enter into a fixed maintenance contract when it has the ability to readily detect adverse maintenance trends regarding an asset and is given the ability to take pro-active steps to address problems before they become major. The cost-savings associated with such a pro-active approach by an expert may be shared to the benefit of the business and the maintenance organization. Similarly, a leasing company that can reduce ownership risk through asset monitoring and appropriate asset utilization is more likely to agree to a hybrid minimum term payment and asset usage billing system or even a usage based billing system with no minimum payments.

[0011] Various objects and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the preferred embodiment, when read in light of the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] **FIG. 1** is a schematic block diagram of a prior art computer based system for tracking and managing a plurality of assets.

[0013] **FIG. 2** is a flow chart of a prior art method for tracking and managing assets in accordance with the prior art computer based system illustrated in **FIG. 1**.

[0014] **FIG. 3** is a schematic block diagram of a computer-based system for tracking and managing a plurality of assets in accordance with this invention.

[0015] **FIGS. 4A through 4C** are three portions, respectively, of a flow chart of a method for tracking and managing assets in accordance with the computer based system illustrated in **FIG. 3**.

[0016] **FIG. 5** illustrates the relationship of various parties to a database associated with an analysis controller.

[0017] **FIG. 6** is a flow chart of a sub-system illustrating the analysis of asset-related information to determine responsibility for asset utilization, and developing a lease relationship between an asset owner and an asset user based on asset utilization criteria.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0018] Referring now to the drawings, there is illustrated in **FIG. 1 a** schematic block diagram of a prior art computer based system, indicated generally at **10**, for tracking and managing a plurality of assets, several of which are indicated generally at **11**. The assets **11** are illustrated as being a plurality of pieces of movable industrial equipment, such as a plurality of conventional forklifts or similar machinery, used in the manufacture of goods in a typical factory environment. However, the prior art method could be used to track and manage any type of asset **11**, such as those described above, used in the manufacture of goods or the performance of services. The basic structure and operation of each of the forklifts **11** are well known in the art and, therefore, require no discussion for a complete understanding of this invention.

[0019] The prior art system **10** further included a remote analysis system, indicated generally at **12**, for tracking and managing the assets **11**. The remote analysis system **12** was completely separate and apart from the assets **11** and included an analysis controller **13** having one or more input devices **14** and one or more output devices **15** connected thereto. The remote analysis system **12** could be embodied as any conventional electronic controller, such as a microprocessor-based computer device. The input device **14** was embodied as a keyboard or other conventional mechanism for manually inputting data in electronic form to the analysis controller **13** for processing in the manner described below. The output device **15** was embodied as a printer or other conventional mechanism for generating a hard copy of the management information generated by the analysis controller **13** in the manner described below.

[0020] Referring now to **FIG. 2**, there is illustrated a flow chart, indicated generally at **20**, of a prior art method for tracking and managing the assets **11** in accordance with the prior art computer based system **10** illustrated in **FIG. 1**. Throughout this discussion, reference will be made to a first person or entity that owns or operates the assets **11** that are being tracked and to a second person or entity that is responsible for tracking the management information relating to such assets **11**. Notwithstanding this, it will be appreciated that a single person or entity may not only own and operate the assets **11**, but also track the management information relating thereto.

[0021] In an initial step **21** of the prior art method **20**, a record was created for each individual asset **11** by the person or entity responsible for tracking such assets, such as one of the forklifts **11** illustrated in **FIG. 1**. This record was created electronically within the analysis controller **13** by means of the input device **14** and included a variety of information that was desired to be tracked for management purposes. First, the record included information that uniquely identified the particular asset **11** being tracked. Such identification information included, for example, data regarding the make, model, year, and serial number of the asset **11**, plus any customer-assigned identification number. Second, the record included information that related to the operational characteristics of the particular asset **11** being tracked, such as the physical requirements or limitations of the asset **11** (mast height, load capacity, type of tires for the forklift **11**, for example), the type of fuel used, and the period of time or

usage between the performance of periodic maintenance. Third, the record included information relating to the acquisition of the asset **11** by the owner or lessee thereof. Such acquisition information included, for example, the type and date of acquisition (purchase or lease, for example), the name of the owner or lessee, the location at which the asset **11** is used, the expected amount of usage of the asset **11** (one, two, or three shifts, for example), and the cost of the acquisition or lease. Furthermore, the record included an area for adding additional information or remarks as desired.

[**0022**] In a second step **22** of the prior art method **20**, it was determined whether a maintenance invoice had been received by the person or entity responsible for tracking the assets **11**. Typically, a maintenance invoice was a written communication that was generated created by or at the request of the person or entity that owned or operated the assets **11**. The maintenance invoice was usually generated upon the occurrence of an event relating to the particular asset **11** and generally contained information regarding the status of one or more operational characteristics of that asset **11**. For example, after a particular forklift **11** had been operated by the person or entity that owned or operated the asset **11** for a particular period of time, it would require the performance of some maintenance. This maintenance may, for example, have constituted routine preventative service as a result of the elapse of a predetermined period of time or usage. Alternatively, such maintenance may have constituted non-routine service, such as a repair of a mechanical breakdown. In either event, a maintenance invoice was generated as a result of the performance of that maintenance. The occurrence of other events related to the assets **11** could also result in the generation of maintenance invoices. In many cases, the maintenance was performed by a maintenance organization having specialized knowledge of asset **11** and its long-term care.

[**0023**] Regardless of the nature of the event that caused them to be generated, the maintenance invoices were generated in hard copy form and contained therein certain information that was desired to be tracked for management purposes, such as the date and nature of the maintenance that was performed, the amount of usage of the asset **11** as of the date of such maintenance, and the cost of such maintenance. To perform the second step **22** of the prior art method **20**, the maintenance invoices were required to be physically delivered from the location where the assets **11** were being used or serviced to the location of the analysis controller **13** or to the location of the input device **14** of the analysis controller **13**. By physically delivered, it is meant that the maintenance invoice was transmitted in a non-electronic, hard copy form (including, for example, by facsimile) from the person or entity that owned or operated the asset **11** (and who performed, or had performed, the maintenance on the asset **11**) to the person or entity responsible for tracking the assets **11**.

[**0024**] As shown in **FIG. 2**, the prior art method **20** continuously repeated step **22** until it was determined that a maintenance invoice had been received by the person or entity responsible for tracking the assets **11**. When that occurred, the prior art method branched from the step **22** to a step **23**, wherein the record contained in the analysis controller **13** relating to the particular asset **11** was updated with the information contained in the maintenance invoice. This step **23** was accomplished by utilizing the input device **14** to manually enter the information contained in the maintenance invoice into the record relating to the particular asset **11** contained in the analysis controller **13**.

[**0025**] Based upon the updated information contained in the record of the asset **11**, the analysis controller **13** was programmed to perform a fourth step **24** of the prior art method **20**, wherein it was determined whether a sufficient period of time or usage had elapsed as to trigger the performance of periodic routine maintenance for that asset **11**. Typically, such determination was made by determining the amount of the elapsed time or usage of the asset **11** (by comparing the most recent indication of the date or amount of usage of the asset **11** with the previous date or amount of usage contained in the record stored in the analysis controller **13**), and by comparing such elapsed time or amount of usage with a predetermined standard (also contained in the record of the asset **11** stored in the analysis controller **13**). If it was determined that a sufficient amount of elapsed time or amount of usage had occurred, the method **20** branched from the step **24** to a step **25**, wherein a hard copy maintenance report was generated by the output device **15**. Then, in step **26** of the prior art method **20**, the maintenance report generated in the step **25** was physically delivered from the person or entity responsible for tracking the asset **11** to the person or entity that owned or operated the asset **11**. The maintenance report advised the person or entity that owned or operated the asset **11** that the time had arrived for the performance of periodic routine maintenance.

[**0026**] Thereafter, the prior art method **20** entered a step **27**, wherein it was determined whether a predetermined period of time had elapsed to generate a periodic management report covering some or all of the assets **11** being tracked. Alternatively, if in step **24** of the prior art method **20**, it was determined that a sufficient amount elapsed time or amount of usage had not yet occurred, the method **20** branched directly from the step **24** to the step **27**. In either event, such management reports were typically generated on a monthly basis. Thus, if the end of the month had occurred, the prior art method **20** branched from the step **27** to a step **28** wherein a hard copy management report was generated by the output device **15**. Then, in step **29** of the prior art method **20**, the management report generated in the step **28** was physically delivered from the person or entity responsible for tracking the asset **11** to the person or entity that owned or operated the asset **11** The management report advised the person or entity that owned or operated the asset **11** of the status of some or all of the assets **11** that were being tracked, allowing various management oversight and decisions to be made at that time. Thereafter, the prior art method **20** returned from the step **29** to the step **22**, wherein it was determined whether a maintenance invoice had been created by or at the request of the person or entity that owns or operates the assets **11** and was physically delivered to the person or entity responsible for tracking the assets **11**. Alternatively, if in step **27** of the prior art method **20**, it was determined that a predetermined period of time had not yet elapsed to generate a periodic management report covering some or all of the assets **11** being tracked, then the method **20** returned directly from the step **27** to the step **22**.

[**0027**] Referring now to **FIG. 3**, there is illustrated schematic block diagram of a computer based system, indicated generally at **30**, for tracking and managing a plurality of assets, indicated generally at **31**, in accordance with this invention. As with the prior art system **10** described above,

the illustrated assets **31** are represented as a plurality of pieces of movable industrial equipment, such as a plurality of conventional forklifts or similar machinery, used in the manufacture of goods in a factory environment. However, the method of this invention can be used to track and manage any type of asset **31**, such as those described above, used in the manufacture of goods or the performance of services.

[**0028**] As above, the basic structure and operation of each of the forklifts **31** are well known in the art, and, therefore, require no discussion for a complete understanding of this invention. However, unlike the forklifts **11** of the prior art system **10**, a data acquisition device **32** is provided on each of the forklifts **31** for sensing and storing one or more operating characteristics of the associated forklift **31**. The basic structure and operation of each of the data acquisition devices **32** are conventional in the art. For example, each of the data acquisition devices **31** may be embodied as an electronic processor or controller that can sense or be otherwise responsive to one or more operating conditions of the associated forklift **31**. Each of the data acquisition devices **31** can be responsive to any desired operating conditions of the forklift **31** that might be considered important in making effective management decisions regarding the operation of the forklift **31**. Such desired operating conditions can, for example, include the time duration of use (and non-use), distances traveled, the extent of fork usage, the nature of hydraulic system utilization, and the like. More typically for industrial assets, the most importance criteria is time duration of use. The sensed operating conditions of the forklifts **31** are preferably stored at least temporarily in a memory of the data acquisition device **32** for subsequent communication to a remote analysis system, indicated generally at **50**, for analysis in the manner described in detail below. Thus, the data acquisition devices **32** sense and store the desired operating conditions for each of the forklifts **31** during use.

[**0029**] Each of the forklifts **31** is further provided with a transmitter **33** or other communications system for transmitting the acquired data from the data acquisition device **32** to the remote analysis system **50** for analysis. Each of the transmitters **33** may be embodied as any conventional device for transmitting the acquired data to the remote analysis system **50**, such as a hard-wired communications interface. However, as is well known, each of the forklifts **31** is a movable vehicle that is capable of traveling extensively throughout the particular environment in which it is used. To facilitate the transmission of the acquired data, therefore, the transmitter **33** is preferably embodied as a wireless communications system, such as represented by an antenna **34**. The transmitters **33** and the wireless communications systems **34** can be embodied as conventional radio frequency transmitters provided on each of the forklifts **31** that transmit electromagnetic signals. However, other well known forms of wireless communication, such as those utilizing light or sound, may be used in lieu of a radio frequency transmitter.

[**0030**] The wireless communications systems **34** are adapted to transmit signals that are representative of the sensed operating conditions of the forklifts **31** through space to a receiver **35**. In contrast to the forklifts **31** that can travel extensively throughout the environment in which they are operated, the receiver **35** is preferably provided at a fixed location within that environment. If desired, a plurality of such receivers **35** may be provided at different locations within the environment in which the forklifts **31** are operated. As the forklifts **31** move about the environment during use, they will occasionally pass by or near the receiver **35**. When this occurs, the receiver **35** receives the data transmitted from the respective data acquisition units **32**. The receiver **35** is also conventional in the art.

[**0031**] Preferably, the data acquisition units **32** and the receivers **35** are in bi-directional communication with one another. One advantage of such bi-directional communication is that the data acquisition unit **32** can send out a query signal on a predetermined basis to be received by the receiver **35** when the two units **32** and **35** are sufficiently close to communicate reliably with one another. Thus, when the data acquisition unit **32** contacts the receiver **35**, the receiver **35** can send a first signal back to the data acquisition unit **32** to instruct it to begin transmitting the acquired data. At the completion of the data transfer, the receiver **35** can send a second signal back to the data acquisition unit **32** to acknowledge the receipt of the transmitted data. A conventional error checking algorithm can be used to confirm the accuracy and completeness of the transmitted data and, if necessary, request a re-transmission thereof.

[**0032**] Another advantage of such bi-directional communication is that data in the form of new commands, program updates, instructions, and the like can be sent to the data acquisition units **32** from the receiver **35**. In some instances, such as when a data acquisition unit **32** is in generally continuous communication with a receiver **35**, a user of the forklift **31** can be prompted to provide certain information for transmission to the receiver **35** for further analysis.

[**0033**] The receiver **35** is connected to a local controller **36**. The local controller **36** is also, of itself, conventional in the art and may be embodied as an electronic controller that is adapted to receive and store at least temporarily the data from each of the receivers **35**. Alternatively, if the assets **31** are fixed in position, such as in the case of a plurality of stationary machines used in a manufacturing environment, the receiver **35** or receivers **35** may be provided on movable structures that move about the environment to receive the information transmitted therefrom. In either event, it is desirable that the local controller **36** acknowledge receipt of the information transmitted from the data acquisition devices **32**, allowing the data acquisition devices **32** to delete the transmitted information and begin storing newly acquired information. A combined system including the data acquisition device **32**, the transmitter **33**, the wireless communications system **34**, the receiver **35**, and software for operating the local controller **36** to gather and report data is commercially available, such as from I.D. Systems, Inc. of Hackensack, N.J. or Requip (formerly SXI).

[**0034**] In a preferred embodiment, the various elements located in an asset **31** are hardwired into the electrical system of the asset to minimize the possibility of undesirable failure or tampering.

[**0035**] Thus, after the forklifts **31** have been operated for a period of time, the local controller **36** will have gathered and stored therein a certain amount of information regarding the individual operating characteristics for each of the forklifts **31**. The local controller **36** is programmed to periodically transmit the information stored therein to the remote analysis system **50** for analysis. This can be accomplished by providing the local controller **36** with a conven-

tional modem **37** or other communications device that can convert the stored information into a format that is compatible for transmission through an electronic communications network, such as the internet **40**. As is well known, the Internet **40** is a digital electronic communications network that connects computer networks and organizational computer facilities around the world. Access to the Internet **40** can be easily obtained in most locations through the local telephone lines or by similar means.

[**0036**] The system **30** of this invention may be used to track and manage a plurality of assets **31** located at any desired physical location. Additionally, the system **30** of this invention may be used to track and manage assets **31** located at a plurality of different physical locations, as suggested by the dotted lines in **FIG. 3**. Each different physical location can be provided with one or more receiver **35**, a local controller **36**, and a modem **37** to connect the system **30** to the Internet **40**.

[**0037**] As mentioned above, the sensed operating conditions of the forklifts **31** are intended to be transmitted to the remote analysis system **50** for analysis. Referring again to **FIG. 3**, it can be seen that the remote analysis system **50** includes an analysis controller **51** that is connected to communicate through the internet **40** by means of a modem **52** or similar communications device. If desired, a communications server **51***a* may be connected between the analysis controller **51** and the modem **52**. The communications server **51***a* is provided to selectively receive and organize the information from each of the local controllers **36** for delivery to the analysis controller **51**. The analysis controller **51** can be embodied as any conventional electronic controller that is capable of receiving the sensed operating conditions of the forklifts **31** and for processing that information in a desired manner described in detail below. Ideally, the sensed operating conditions of the forklifts **31** are used to automatically generate and analyze management reports relating to the procurement and utilization of a plurality of the forklifts **31** to maximize productivity and to reduce operating costs and administrative burdens. An input device **53** and an output device **54**, both of which are conventional in the art, may be connected to the analysis controller **51**.

[**0038**] As also shown in **FIG. 3**, one or more administrative controllers **55** (only one is illustrated) can be connected to the internet **40** through respective modems **56** or similar communications devices. Each of the administrative controllers **55** can also be embodied as any conventional electronic controller that can request and receive information from the remote analysis system **50** through the Internet **40**. In a manner that is described in detail below, the administrative controllers **55** are provided to request and receive the management information generated by the remote analysis system **50**. If desired, the local controller **36** can also function as an administrative controller **55**, although such is not necessary. An input device **57** and an output device **58**, both of which are conventional in the art, may be connected to the administrative controller **55**.

[**0039**] Referring now to **FIGS. 4A through 4C**, there is illustrated a flow chart, indicated generally at **60**, of a method for tracking and managing the assets **31** in accordance with this invention using the computer based system **30** illustrated in **FIG. 3**. Throughout this discussion also, reference will be made to a first person or entity that owns or operates the assets **31** that are being tracked and to a second person or entity that is responsible for tracking information relating to such assets **31**. As above, it will be appreciated that a single person or entity may not only own and operate the assets **31**, but also track the information relating thereto.

[**0040**] In an initial step **61** of the method **60**, a record is created for each individual asset **31** by the person or entity responsible for tracking such assets, such as one of the forklifts **31** illustrated in **FIG. 3**. The record can be created electronically within the analysis controller **51** by means of the input device **53** and can include a variety of information that is desired to be tracked for management purposes, including all of the information described above in connection with the forklifts **11** and the analysis controller **13**. Additionally, the record can further include information regarding the nature and time duration of a warranty provided by the manufacturer or supplier of the assets **31**. Such warranty information can be used in the manner described in further detail below to automatically determine whether the responsibility for the maintenance being performed on the asset **31**, either in whole or in part, should rest with the manufacturer or the supplier of the asset **31** or with the owner or user of the asset **31**.

[**0041**] In a second step **62** of the method **60**, it is determined whether a maintenance invoice has been received by the person or entity responsible for tracking the assets **31**. Such maintenance invoices can be generated and delivered in the same manner as described above. If it is determined that a maintenance invoice has been received by the person or entity responsible for tracking the assets **31**, the method branches from the step **62** to a step **63**, wherein the record contained in the analysis controller **51** relating to the particular asset **31** is updated with the information contained in the maintenance invoice in the same manner as described above. Next, the method enters a step **64** wherein the record contained in the analysis controller **51** relating to the particular asset **31** is updated with information from the internet **40**. Alternatively, if it is determined that a maintenance invoice has not been received by the person or entity responsible for tracking the assets **31**, the method branches directly from the step **62** to the step **64**.

[**0042**] As discussed above, the local controller **36** will have gathered and stored therein a certain amount of information regarding the individual operating characteristics for each of the forklifts **31**. The local controller **37** is programmed to periodically transmit the information stored therein to the remote analysis system **50** for analysis. The analysis controller **51** can include a memory circuit for storing this information from the local controller **36**. The transmission of the information from the local controller **36** to the analysis controller **51** can be performed in real time, upon occurrence of predetermined events (such as the gathering of a predetermined amount of information), or at predetermined time intervals. In any event, the record contained in the analysis controller **51** is automatically updated with the latest information regarding the status of the asset **31**, without any human intervention.

[**0043**] Based upon the updated information contained in the record of the asset **31**, the analysis controller **51** next determines whether a sufficient period of time or usage has elapsed as to trigger the performance of periodic routine

maintenance for that asset **31**. This determination can be made in the same manner as described above in connection with 24 of the prior art method **20**. If it is determined that a sufficient amount elapsed time or amount of usage had occurred, the method **60** branches from the step **65** to a step **66**, wherein an electronic maintenance report is generated. If desired, a hard copy of the maintenance report can also be generated by an output device **54** connected to the analysis controller **51**. Then, in step **67** of the method **60**, the electronic maintenance report generated in the step **66** is delivered from the person or entity responsible for tracking the asset **31** to the person or entity that owns or operates the asset **31** through the Internet **40**. As above, the maintenance report can advise the person or entity that owns or operates the asset **31** that the time had arrived for the performance of periodic routine maintenance. Moreover, if a specific fault code has been Alternatively, the maintenance report **55** can be delivered to a specialized maintenance organization responsible for maintenance of the assets **31**. The electronic maintenance report can, for example, be delivered through the Internet **40** to one or more of the administrative controllers **55** as desired. Alternatively, or additionally, the electronic maintenance report can be delivered through the Internet **40** to one or more of the local controllers **36**. Also, in step **68** of the method **60**, the electronic maintenance report generated in the step **66** is posted on a website maintained on the Internet **40**. The website may be maintained either by the person or entity responsible for tracking the as set **31** or by the person or entity that owns or operates the asset **31** through the Internet **40**. As opposed to the direct electronic delivery of the maintenance report to a particular person or group of persons contemplated in the step **67**, the step **68** contemplates that the maintenance report is made available to such person or group of persons at their request over the Internet **40**.

[**0044**] Thereafter, the method **60** enters a step **69**, wherein it is determined whether any maintenance that has been performed on the asset **31** occurred within the warranty period provided by the manufacturer or supplier. Alternatively, if in the step **65** of the method **60**, it was determined that a sufficient amount elapsed time or amount of usage had not yet occurred, the method **60** branches directly from the step **65** to the step **69**. In either event, this determination can be made by comparing the date of service or amount of usage of the asset **31** with the warranty information contained in the record for that asset **31** contained in the analysis controller **51**. If it is determined that service on the asset **31** occurred within the warranty period, the method **60** branches from the step **69** to a step **70**, wherein an electronic warranty report is generated. If desired, a hard copy of the warranty report can also be generated by the output device **54** connected to the analysis controller **51**. Then, in step **71** of the method **60**, the electronic warranty report generated in the step **70** is delivered from the person or entity responsible for tracking the asset **31** to the person or entity that owns or operates the asset **31** through the Internet **40**. As above, the warranty report can advise the person or entity that owns or operates the asset **31** that the service performed on the asset **31** should be paid for by the manufacturer or supplier of the asset **31**. The electronic warranty report can, for example, be delivered through the Internet **40** to one or more of the administrative controllers **55** as desired. Alternatively, or additionally, the electronic warranty report can be delivered through the Internet **40** to one or more of the local controllers **36**. Also, in step **72** of the method **60**, the electronic warranty report generated in the step **70** is posted on a website maintained on the Internet **40**. The website may be maintained either by the person or entity responsible for tracking the asset **31** or by the person or entity that owns or operates the asset **31** through the Internet **40**. As opposed to the direct electronic delivery of the warranty report to a particular person or group of persons contemplated in the step **71**, the step **72** contemplates that the warranty report is made available to such person or group of persons at their request over the Internet **40**.

[**0045**] Thereafter, the method **60** enters a step **73**, wherein it is determined whether a predetermined period of time has elapsed to generate a periodic management report covering some or all of the assets **31** being tracked. Alternatively, if in step **69** of the method **60**, it was determined that a sufficient amount elapsed time or amount of usage had not yet occurred, the method **60** branches directly from the step **69** to the step **73**. In either event, such management reports are typically generated on a monthly basis. Thus, if the end of the month has occurred, the method **60** branches from the step **73** to a step **74**, wherein an electronic management report is generated. If desired, a hard copy of the management report can also be generated by the output device **54** connected to the analysis controller **51**. Then, in step **75** of the method **60**, the electronic management report generated in the step **74** is delivered from the person or entity responsible for tracking the asset **31** to the person or entity that owns or operates the asset **31** through the Internet **40**. As above, the management report can advise the person or entity that owns or operates the asset **31** of the same information as the management reports discussed above. The electronic management report can, for example, be delivered through the Internet **40** to one or more of the administrative controllers **55** as desired. Alternatively, or additionally, the electronic management report can be delivered through the Internet **40** to one or more of the local controllers **36**. Also, in step **76** of the method **60**, the electronic warranty report generated in the step **74** is posted on a website maintained on the Internet **40**. The website may be maintained either by the person or entity responsible for tracking the asset **31** or by the person or entity that owns or operates the asset **31** through the Internet **40**. As opposed to the direct electronic delivery of the management report to a particular person or group of persons contemplated in the step **75**, the step **76** contemplates that the management report is made available to such person or group of persons at their request over the Internet.

[**0046**] **FIG. 4C** demonstrates an additional functional aspect of method **60** using the inventive system. In addition to determining whether a maintenance invoice has been received, if scheduled maintenance has been performed, and determining the party responsibility for certain maintenance activities, it is possible to poll asset data points at point **76** from an analysis controller database **78** associated with one or more discrete analysis controllers **51** that may be associated with one or more businesses. A plurality of databases **78** are shown. One or more separate databases may be combined to form a logical database **78**. When a maintenance organization has access to various asset fleets of the same type or make of equipment, it may be beneficial to analyze the relevant information using a larger available knowledgebase of information to analyze appropriate trends. By analyzing the data points, certain maintenance trends can

be analyzed and problems can be anticipated before they affect asset utilization. For example, if it turns out that asset **31** has a tendency to need new batteries after a certain period of usage; the need for such batteries can be anticipated and stocked on site when appropriate to facilitate maintenance. As shown in **FIG. 4C**, once the various trends have been analyzed for assets **31**, at decision point **80** it is determined whether preventative maintenance is required. If it is required, the maintenance is performed as shown at point **82** and the information is stored in database **78**. The asset data points are then analyzed again until it is determined that no further preventative maintenance is required. Then the system terminates at point **84**. Thus, **FIGS. 4A through 4C** illustrate the use of critical information from assets **31** to perform maintenance and to provide a methodology for providing access to information by various third parties.

[**0047**] **FIG. 5** illustrates the beneficial interrelationships that promote efficiency by having various parties associated in some way with an asset **31** in one or two-way communication with analysis controller **51** either by way of administrative controller **55**, reports **71** or **75**, web site postings electronic mail, or the like. As already discussed above, asset **31** provides usage and performance data that is stored in the asset controller **51** according to certain predetermined criteria important for that asset. As also discussed above, a maintenance organization **86** both receives and provides information to database **78**. While business **90** may provide its own maintenance of assets **90**, for the discussion a separate maintenance organization is illustrated.

[**0048**] Warranty information as shown by steps **70** through **72** of **FIG. 4B** is of particular interest to the asset manufacturer or supplier **88**. While it may not be appropriate for a supplier **88** to be able to alter information in database **78**, the ability to quickly and accurately collect information concerning warranty obligations and the like is of particular benefit to all of the parties. For example, warranty issues may be caught more quickly, ultimately reducing asset cost a n d operation while simultaneously promoting asset up time. The ability of the asset user **90** to analyze and administer assets **31** has also been discussed in detail. However, key advantages also result by allowing the owner of asset **31** to analyze key data associated with asset **31**. In the illustrated embodiment, it is assumed that the owner of the asset **31** is a separate asset owner **92** such as a leasing company, as opposed to business **90** itself, although this is not required.

[**0049**] The advantages of an asset owner **92** having at least one and possibly two-way access to the real-time and historical information stored in analysis controller database **78** as well as the ability to communicate with supplier **88**, maintenance **86**, and business **90**, is illustrated in sub-system **98** illustrated in **FIG. 6**. Sub-system **98** is activated by the asset owner **92** using data from database **78**, but typically utilizing its own lease administration and billing systems. In many cases it is also using its own fleet analysis and management systems, which are typically aggregating information from a number of different fleets associated with a plurality of businesses **90**. These various systems, one or more of which may be used independently or in concert, are collectively shown at point **99**. As noted above, web-site access, generated reports, analysis controllers **51**, and administrative controllers **55** provide exemplary access points for pulling asset information from system **30**.

[**0050**] An asset owner **92** and an asset user such as business **90** share the common interest in maximizing efficiency by taking into account such variables as asset usage and asset costs. The more information that is available, the more likely that efficiency is maximized. In traditional leasing relationships involving non-fixed or movable assets such as forklifts where minimal asset utilization information is available, the burden of determining the point of maximum efficiency typically rests with business **90**, since it has control over the asset. Therefore, a leasing company **92** typically enters into a lease arrangement where a fixed lease amount is paid in periodic payments by business **90** over the life of the lease. At best, only minor flexibilities are provided. When leasing company **92** regains control of an asset **31** at the end of the lease term, there is uncertainty concerning the condition of the asset. This uncertainty also typically rests with business **90** in the form of a financial cushion incorporated into the leasing relationship.

[**0051**] However, such uncertainty is minimized in the present invention. As shown at point **100**, asset owner **92** is able to analyze the various desired objectively generated asset data points associated with an asset **31**. As noted above, these data points can include the time of asset usage within a fixed time period, distance traveled, and certain performance parameters associated with the particular asset (e.g., hydraulic system usage or fork usage for fork lifts). As noted above, in practice, for industrial assets the time of use is the most important single data point. Then, as shown at point **102**, asset owner **92** may analyze maintenance considerations. For example, a major routine overhaul as compared to a system failure can be analyzed. Then at point **104**, the asset owner **92** can compare the raw data from the asset with maintenance conducted during the same time period. By comparing the raw data with maintenance considerations, the owner is able to analyze the asset utilization under the control of business **90** if maintenance organization **86** and supplier **88** are different third parties. For example, the asset owner **92** can determine that an asset **31** has been used very little during the time period, even allowing for maintenance. Alternatively, the owner may determine that the asset is being used continuously when not undergoing maintenance, possibly suggesting that additional assets may be appropriate to reduce overall maintenance stress on the pre-existing asset.

[**0052**] Additional information can be analyzed by the asset owner as shown at decision point **106**. Typically, the information includes data associated with other parties having access to database **78**. As shown at point **108**, for example, the asset owner **92** can evaluate the maintenance relationship with maintenance organization **86**. If the relationship has been very positive, an appropriate incentive may be provided to the organization in the form of shared cost savings. Alternatively, if the relationship has been negative, an appropriate penalty may also be implemented. The same considerations are available if business **90** acts as its own maintenance organization **86**.

[**0053**] Similarly, the asset owner **92** may evaluate its relationship with the asset supplier **88** as shown at point **110**. The information may affect asset payments from the owner to the supplier or the future relationship of the parties.

[**0054**] These various advantages are applicable even if asset owner **92** and business **90** are the same entity. How-

ever, more typically with industrial equipment, asset owner **92** is different than asset user **90**, where the two parties have entered into a lessor/lessee relationship. In such a case, the information in database **78** may be used to mutually maximize the relationship between the asset owner **92** and the business **90**. With appropriate safeguards asset owner **92** may be willing to share in a greater portion of the risk associated with the utilization of asset **31** in determining a lease rate based on an analysis of each user fleet or individual asset as shown at point **112**. Most significantly, rather than entering into a traditional fixed lease amount as noted above, asset owner **92** may be willing to enter into a hybrid lease arrangement wherein the lease charge may be a combination of one or more of the following elements: 1) a minimum payment that has to be made if asset utilization is below a pre-determined minimum threshold; 2) a usage based-payment that is made if usage is above the pre-determined minimum threshold and below a pre-determined maximum threshold; 3) a penalty payment or surcharge is made if utilization is higher than the pre-determined maximum threshold; and 4) payments/rewards based on incentive issues such as asset re-allocation or timely maintenance.

[**0055**] The decision of whether to use usage-based billing based on one or more objective criteria based on an analysis of asset utilization is shown at decision point **114**. The decisions to charge either a minimum payment if a certain usage level is not met, or to charge a usage penalty above a maximum appropriate usage level, are shown by decision points **116** and **118** respectively. Thus, a variable-amount lease may be developed based on an analysis of objective criteria that is based in large part on the actual portion of an asset's life that is consumed by the asset user (e.g., usage hours). In a preferred embodiment, the analysis is based on a pre-determined usage/pricing matrix in combination with actual usage for a specified time period. Once a level of maximum efficiency has developed, leasing will typically be primarily, if not solely, based on asset usage billing.

[**0056**] Through the use of the innovative leasing arrangement based on improved information availability to asset owner **92**, the expenses of an asset user such as business **90** can be more accurately aligned with usage and asset value consumption. More operational flexibility is provided to business **90**. When leasing is based predominantly on asset usage billing, a business **90** is able to adopt true off-balance sheet financing (i.e., the business is not required to note a financial obligation even in the footnotes of various financial reports as opposed to standard off-balance sheet leasing where a company must disclose the lease in footnotes even if the lease does not show up on the balance sheet). At the same time, asset owner **92**, can collect information from a variety of sources to maximize its relationships with its own vendors and customers to the benefit of all related parties by minimizing inefficiencies and providing appropriate accountability with maximum accuracy and validity tied to a minimal likelihood for mistakes, misinformation, or even fraud.

[**0057**] These various factors can be adjusted dynamically by the asset owner **92** as a knowledge base is collected within its internal systems **99** and based on the actions of the other related parties. For a sophisticated asset owner with numerous fleets, it can conduct appropriate analyses over all of its fleets to determine certain trends, which it may advantageously use.

[**0058**] For example, if supplier **88** or maintenance organization **86** is responsible for abnormally low asset utilization as opposed to actions within the control of business **90**, then the risk associated with these possibilities can be shared between asset owner **92** and various affected businesses **90** and transferred in some fashion to the responsible party. Thus, in a more preferred embodiment of the invention, asset usage is adjusted for maintenance considerations if business **90** is not responsible for its own maintenance.

[**0059**] As shown at point **120**, once the readily available information is analyzed in view of the business relationship between an asset owner **92** and a business **90**, an invoice and billing module associated with the asset owner's own internal systems **99** is invoked that generates an appropriate invoice that is sent by the asset owner to the business for payment and sub-system **98** terminates at point **122**. In a preferred embodiment, once sub-system **98** is developed for a particular situation, and in the absence of an extraordinary event, invoicing is automated based strictly on the objective criteria developed with minimal outside involvement.

[**0060**] A key advantage of the present invention is that real-time data is collected by data acquisition device **34** and timely transmitted to local controller **36** for transmission to database **78** of analysis controller **51**. If incomplete or limited data representing only a small portion of the appropriate asset data points are transmitted, then appropriate decisions cannot be made to maximize asset utilization. For example, in the case of forklifts, both time of usage and distance traveled help provide information concerning asset utilization and maintenance considerations.

[**0061**] Thus, the computer based system **30**, including sub-system **98**, of the present invention provides a superior method for tracking and managing the assets **31** than the prior art system **10**. First, by providing the assets with the data acquisition devices **32** and the communications system **33** and **34**, the operational characteristics and other information regarding the assets **31** is automatically sensed and transmitted to the analysis controller **51** on a real time basis, without requiring human intervention or assistance. Second, the analysis controller **51** is programmed to analyze such information as it is received and to automatically generate maintenance and warranty reports in response thereto. Third, all of the reports generated by the analysis controller **51** are automatically delivered to the appropriate persons through the Internet **40**, either directly to one or more of the administrative controllers **55** or by posting on a web site, electronic mail or similar mechanisms. Fourth, as shown by sub-system **98**, the information can be used to maximize asset usage efficiency. As a result, the computer based system **30** facilitates the gathering, analyzing, and delivering of information relating to the procurement and utilization of the assets **31** so as to maximize productivity and to reduce operating costs and administrative burdens to the benefit of all parties having a relationship with the asset and an interest in its performance.

[**0062**] The providing of maintenance to an asset **31** is illustrated in further detail in **FIG. 7**. In addition to determining whether it is necessary to provide scheduled maintenance as noted at step **65** of **FIG. 4A**, changes in operational parameters associated with asset **31** as shown at point **150** may result in the generation of a specific fault code if a maintenance problem is detected that requires a more expe-

ditious response. The fault code may be generated by the asset itself using one or more sensors associated with operational parameters of asset **31** as shown by point **152** and communicated to the data acquisition device **32**. In addition, analysis controller **51** may analyze the raw operational data received from the asset **31** and compare it with analysis controller database **78** including the history of the specific asset **31** as well as the history of similar assets from which maintenance trends may be determined as discussed with respect to **FIG. 4C** above. Based on an analysis of such trends, proactive lower cost maintenance can be timely performed that results in the avoidance of higher cost maintenance at a later date, which happens in the absence of real-time information available for review and analysis.

[**0063**] A fault code may even be generated based on the actions of the asset operator. In a preferred embodiment of the invention, an electronic checklist **154** is completed by the asset operator on a regular basis, which may include information concerning asset performance that is more detailed than that available from a review of raw operational parameters. In accordance with OSHA requirements, for example, at the end of each shift, a forklift operator must complete a checklist concerning the performance of the asset during the shift. Some of the questions associated with checklist **154** are directed to maintenance issues. Therefore, in a preferred embodiment of the invention, checklist **154** would be completed electronically at the asset **31**, and transmitted by way of the data acquisition device **32** to analysis controller **51** as discussed above. The information would be analyzed to determine if an OSHA/repair need is identified. Preferably, the analysis is automated in accordance with a comparison of the operational status with pre-determined rules. For example, if a question asks if there is a hydraulic leak for a forklift and the answer is "yes", then maintenance would be appropriate.

[**0064**] Once it is determined that maintenance of some type is required as shown at point **156** based on an analysis of the operational status of asset **31**, a maintenance report **66** is generated as also shown in **FIG. 4A** and made available electronically at point **67'** such as by the Internet or by posting on a website as also shown in **FIG. 4A**. The use of electronic mail, or the providing of real-time access to the raw data stored within database **78** by the maintenance organization **86**, shown in **FIG. 5**, is also possible to generate the maintenance report **66**. An advantage of providing a maintenance organization **86** real-time access to the raw data representing the operational status of asset **31** is that it may develop specialized analysis tools based on its own expertise in maintenance, resulting for example in the creation of specialized rules for use in automatically analyzing raw data in determining whether maintenance is required, minimizing the need for manual review and determination.

[**0065**] In a preferred embodiment, the priority of the proposed maintenance required **158** is noted on the maintenance report. For example, critical maintenance issues should take precedence over routine issues. Moreover, the system generally institutes an approval process as shown at point **160**. For example, if the proposed maintenance is related to warranty work such as noted with respect to step **69** of **FIG. 4B**, the manufacturer or supplier should approve the maintenance. If a lessee is responsible for the proposed maintenance, it should approve the maintenance before it is performed. In some cases, the maintenance organization **86** itself approves the maintenance, such as when it has a contract that involves pre-payment of particular maintenance. Finally, as shown at point **162**, in some cases it may be desirable to have the lessor or owner of the asset have the ability to review and override any refusals to perform maintenance since it has the ultimate responsibility for asset **31**. If no approvals are given, the process is terminated at point **164**. A review of any automated rules that generated a request for maintenance approval may also be appropriate. When maintenance approval is rejected, any automated rules that generated the original maintenance request can be fine-tuned by including the results of the approval process. Over time, almost all maintenance requests should be generally approved. Information regarding approval is stored in database **78**.

[**0066**] For preventative maintenance, it is expected that pre-approval will generally be granted by the necessary parties based on prior agreement as to the nature and timing of such maintenance.

[**0067**] Once maintenance has been approved, a work order **166** is generated. As shown in **FIG. 8**, work order **166** is sent electronically to appropriate maintenance personnel that contains all of the critical operating data required to effectively schedule and carry out the maintenance. Typically, for example, the data includes hour meter reading, any fault codes, asset identification criteria, operator of record, contact information, and asset location. Moreover, based on information contained within the fault code or retrieved from the knowledgebase, information concerning anticipated parts may also be provided as well as the nearest location from where they may be retrieved (e.g., at a customer location, or from a local servicing dealer). Finally, the work order **166** preferably contains the past recent history of the particular asset **31** so that the mechanic can use this information to expedite maintenance.

[**0068**] In a preferred embodiment of the invention, the work order **166** is transmitted electronically to a handheld device **168** associated with specific maintenance personnel assigned to carry out the maintenance. Moreover, in a more preferred embodiment of the invention, the handheld device **168** is in real-time two way communication with analysis controller database **78**. Thus, under appropriate circumstances the handheld device **168** can access such things as dealer billing systems, inventory listings, customer work order approval records, and fleet management information. Rather than having the work order include the past recent history of the asset **31** to be serviced, it is possible to use the two way communication link to request the necessary history when advantageous to do so.

[**0069**] Once the maintenance is completed, handheld device **168** is used to update database **78** as shown at point **170**, including labor information and an identification of any parts required to effect a repair. If not already clear based on the contents of database **78**, the inventory location from which any parts were pulled should also be provided. Ideally, the information is transmitted on a real-time basis from the handheld device **168**. Alternatively, however, the information can be transmitted upon routine synchronization of the handheld device with database **78**. It is also possible to manually enter the information into the database **78**.

[**0070**] The maintenance information is passed to database **78** where it may be used to generate maintenance tracking

reports **172**, and comprehensive invoices **174** listing both labor and part costs. Since the information is integrated with pre-existing asset information, no re-keying is required. Moreover, as noted above with respect to **FIG. 4C**, the complete maintenance history of a particular asset or class of assets may be reviewed and analyzed in detail for specific trends of interest.

[**0071**] In addition, when parts are used, as shown at point **176**, the system preferably permits comparison of the parts used with existing inventory for the specified parts storage location. Based on maintenance trends associated with a class of assets **31** or a specific asset **31**, it is possible for the system to automatically order replacement parts for an inventory location if the number of parts in a particular inventory fall below a pre-determined threshold as shown at points **178** and **180**. The threshold is calculated at least in part based on an analysis of the prior maintenance of both the asset **31** and the class of assets associated with the asset. Other factors may include the age of the class of assets, the time of the year, usage trends and the like. As one example, in the winter different parts may be required as opposed to in the summer. As another example, more tires may be required for a forklift asset if a number of the assets are reaching a preventative maintenance stage where tires have to be replaced. The system terminates at point **182**.

[**0072**] Thus, the inventive system provides a number of advantages for maintenance. For example, through the use of electronic information transmission and analysis, maintenance information is transferred and available real-time for review and for the initiation of necessary actions such as approval, the tracking of performed maintenance, the ordering of replacement parts to replenish depleted inventories, and automatic invoice generation. Since asset **31** communicates its own maintenance needs in consultation with an appropriate knowledgebase associated with database **78**, human intervention is minimized. As more information is gathered over time, the scheduling of preventative maintenance can be optimized to eliminate either too little or too much maintenance. Further, the system automates a very paper-intensive and time cumbersome process by permitting direct communication with the various information elements associated with an asset **31**. As a result, the flow of data is more effectively controlled, dispersed, routed, monitored, and acted upon. In practice, the number of people involved in the maintenance process can often be reduced while the speed of providing maintenance can be increased. Thus, potential downtime and related performance issues can be more timely addressed.

[**0073**] In accordance with the provisions of the patent statutes, the principle and mode of operation of this invention have been explained and illustrated in its preferred embodiment. However, it must be understood that this invention may be practiced otherwise than as specifically explained and illustrated without departing from its spirit or scope.

1. A maintenance system involving to the gathering and analyzing of data relating to an asset comprising:

a local controller located at a first location for acquiring data that is representative of an operational status of the asset;

an analysis controller located at a second location that is responsive to said acquired data from said local controller for generating an analysis of said acquired data;

a database of historical information representing at least prior maintenance of the asset said analysis including comparing said acquired data to said historical information to determine if proposed maintenance is required;

an electronic communications network connected between said local controller and said analysis controller and permitting transmission of said acquired data from said local controller to said analysis controller; and

a work order generated based on said analysis representing instructions for maintaining the asset.

2. (canceled)

3. A maintenance system as recited in claim 1, further comprising an approval process wherein a responsible party charged with paying for maintaining the asset reviews said analysis.

4. A maintenance system as recited in claim 3, wherein if said responsible party denies an approval, an owning party that owns the asset reviews said analysis.

5. A maintenance system as recited in claim 1, wherein said work order includes asset identification information, said asset identification information comprising at least a subset of an operating characteristic, results of said analysis, operator of record, and asset location.

6. A maintenance system as recited in claim 5, wherein said work order is transmitted electronically to a handheld device, said handheld device in selective two-way communication with said database.

7. A maintenance system as recited in claim 6, wherein said handheld device updates said historical information once maintenance of the asset is complete, an invoice electronically generated based on said update to said historical information.

8. A maintenance system as recited in claim 7, wherein said update of said historical information includes labor information, an identification of any part required to effect maintenance, and the inventory location from which the part was removed.

9. A maintenance system as recited in claim 8, further comprising an inventory comparison sub-system, said sub-system permitting a comparison of any part removed with existing inventory for a specific inventory location to automatically order a replacement part for the inventory location if the number of parts in a particular inventory falls below a pre-determined threshold.

10. A maintenance system as recited in claim 9, wherein said threshold selectively changes as said historical information changes.

11. A maintenance system as recited in claim 6, wherein asset part inventory is electronically accessible to said handheld device.

12. A maintenance system as recited in claim 1, wherein said data representing said operational status comprises at least one of a fault code, an operator checklist generated response, and an operational characteristic of the asset.

13. A method for maintaining an asset comprising the steps of:

activating a local controller located at a first location;

acquiring data at a first location that is representative of an operational status of the asset, which is communicated from the asset to said local controller;

transmitting said acquired data at pre-determined intervals from said local controller to an analysis controller located at a second location using an electronic communications network connected between said local controller and said analysis controller;

analyzing said acquired data, wherein said analysis step comprises the sub-step of comparing said acquired data to a database of historical information representing at least prior maintenance of the asset to determine if proposed maintenance is required, and

generating a work order based on said analysis representing instructions for maintaining the asset.

14. A method as recited in claim 13, wherein said analysis step comprises the further sub-step of:

instituting an approval process of said proposed maintenance.

15. A method as recited in claim 14, wherein said analysis step comprises the further sub-steps of:

a responsible party disapproving said proposed maintenance;

updating said comparing step based on said disapproving; and

creating a knowledgebase minimizing said disapproving over a class of assets corresponding to the asset.

16. A method as recited in claim 14, further comprising the steps of:

carrying out said work order to maintain the asset;

identifying any parts used in said carrying step;

determining an inventory location from which said part was pulled;

comparing an inventory level at said inventory location to a pre-determined threshold; and

automatically ordering a replacement part for said inventory location of the number of parts in a particular inventory fall below said pre-determined threshold.

17. A method as recited in claim 16, wherein said threshold selectively changes as said historical information changes.

18. A method as recited in claim 14, further comprising the steps of:

electronically transmitting said work order to maintenance personnel;

electronically communicating results of maintenance to provide an update of said historical information including labor information and any part required to effect maintenance; and

electronically generating an invoice.

19. A method as recited in claim 18, comprising the steps of:

identifying said parts provided to said analysis controller in said communicating step;

determining an inventory location from which said part was pulled;

comparing an inventory level at said inventory location to a pre-determined threshold; and

automatically ordering a replacement part for said inventory location of the number of parts in a particular inventory fall below said pre-determined threshold.

20. A maintenance system involving the gathering and analyzing of data relating to an asset comprising:

a local controller located at a first location for acquiring data that is representative of an operational status of the asset;

an analysis controller located at a second location that is responsive to said acquired data from said local controller for generating an analysis of said acquired data;

a database of historical information representing at least prior maintenance of the asset, said analysis including comparing said acquired data to said historical information to determine if proposed maintenance is required;

an electronic communications network connected between said local controller and said analysis controller and permitting transmission of said acquired data from said local controller to said analysis controller;

an approval process wherein a responsible party reviews said analysis to confirm that a proposed maintenance is appropriate;

a work order generated based on said analysis of said proposed maintenance and said approval process, representing instructions for maintaining the asset, wherein said work order is transmitted electronically to a handheld device, said handheld device providing an update to said historical information once maintenance is complete, said update including labor information and an identification of any part required to effect maintenance; and

an invoice generated based on said update to said historical information.

21. A maintenance system as recited in claim 20, wherein said update includes the inventory location from which the part was removed and further comprising an inventory comparison sub-system, said sub-system permitting a comparison of any part removed with existing inventory for a specific inventory location to automatically order a replacement part for the inventory location if the number of parts in a particular inventory falls below a pre-determined threshold.

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